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Towed Array Of Hydrophones

User manual

Ver.10b.***beta*** for generation 9 instrument setup

Safety first !

In our experience with small towable hydrophones we never had major nor minor injuries to people or damages to equipment.
Even if unlikely, **please remember that the hydrophone hose and / or the cable could get entangled while in the water**.
The cause of entanglement (a net, a cable, a wreck, a plastic bag or whatever) could retain the hydrophone causing the towing cable to whitstand a very high strain.

This strain could lead to a breaking of the strenght elements of the hydrophone or worse, to an unexpected movement of the cable on-board, up to the cable reel and the amplifier.
The cable reel **must be kept on deck**, well protected from water and rain, and must always be clear so that it can fall in the water if the cable is, for any serious reason pulled away from the ship.
The standard operational configuration is therefore with all the cable, up to this connector, deployed into the water.
The frame of the cable reel must be kept well tightened to the ship, so that it can not go into the water while operating on the cable.
The frame of the cable reel can NOT withstand the 400kg set as breaking strain, so it would break well before the cable. The cable, and the cable only, is the part that must withstand the towing drag. See OPERATIONS for details.

The product described complies with the European Community directions about electricity. Every component in the water is powered over fuse-protected lines and runs under 24V DC maximum.
The product is assembled using commercially available items (CE compliant), and hydrophonic sensors produced in the U.K. by MagRec (directly imported and CE compliant).
The system is completely battery powered up to the headphone amplifier and two standard gel 12V batteries are provided inside the amplifier container.
Two user replaceble fuses are fitted inline right after the two batteries. Access to the fuses is provied from the back cover of the amplifier box.
All components are approved to follow the ROHS directive.

General use rules to be followed

Towed hydrophones are generally considered «dual use» technologies (i.e. they could have both military and scientific/commercial use).
Their production and commerce must then follow specific international rules. Among these rules the most important is that the equipment can not be permanently exported outside the EU territotry without a prior authorization from your local government.
Other rules regarding the use of towed cables in the water may apply in the seas or the areas in which you plan to use this equipment.
Navigation code must be strictly followed when using this equipment.

The hydrophone

On Board

The on-board equipment is make of a black plastic rack container.

It contains:

Two gel batteries (12V each fitted with a fuse),
A box with powering controls, whose logic is described separately,
A 3 channel mixer with panoramic control and headphone output,

A computer interface USB powered with 192kHz sampling frequency,
A two-channel high-pass filter.
Two connectors are available on the front of the amplifier box: the hydrophone connector and the battery charger connector. these two are different connector models and can not be swapped by mistake.

A separate pair of battery chargers are also provided.

The wet part is made of (starting from the near end):

A multipolar connector that matches the hydrophone connector on the front of the amplifier box,
A 210m cable polyurethan jacketed and kevlar reinforced (400kg breaking strain),
The towed hydrophone, made of a stainless steel head, a 5.3m polyurethan pipe with 30mm overall diameter, a plastic (delrin) tail and a stabilizing rope tail. The pipe contains two wideband preamplified hydrophones whose specifications are reported in appendix.
The pipe is filled with isoparaffine oil.

An optional add-on weight for the cable is also provided and could be added on the cable at the position indicated with a black protective extra tape. The use of this additional weight is anyway not encouraged as it alters the standard hydrodynamic behaviour of the instrument set, producing an extra additional tow noise.

The control unit

On the left of the control unit you find the headphone amplifier.
It is the equipment marked as ROLLS (the manufacturer) ProMixPlus Mx54s (the model number). This is a 3 channels mixer that is used, in this setup, to amplify the signal that must go to the headphones, driving the left channel (hydrophone towards the HEAD of the towed hydrophone, or better to the towing boat) to the left ear, and the right channel (tail hydrophone) to the right ear.
This assignement is obtained using the PAN controls that are right

under the channels market as HEAD and TAIL.
In the picture HEAD hydrophone is completely driver to LEFT, while TAIL driven to RIGHT.

The two larger knobs, regulate the volume at the headphones. They must be kept at identical value to have the best possible chance to understand the direction of the source using your built.in earing capabilities.

The two Jack holes (large and small) are identical and offer the same signal output.

The PWR led is on when the headphone amplifier is powered on, while the CLIP led indicates a saturated signal when lit.

On the right side of the ROLLS unit you find the switch.
This is a press button and turns the unit on and off alternatively. This unit must be kept OFF whenever unused.
All other controls, including recessed phantom power, must be left untouched. Serious damage could be made if phantom power is turned on in this system.

On the right of the headphone amplifier/mixer, you find the filter unit. This is a two independent channels unit. It is made to matchthe output/input impedances in this setup. In general the two channels are identical, and the knobs should be used at identical position (for instance 2 for red AND black channels).

This unit has 6 cables at the back, two input cables and four output. It must be seen as a pair of identical circuits: one input and two outputs with the same signal on them but different connectors.
RED channel has a RED sleeve over the connectors to easily identify them

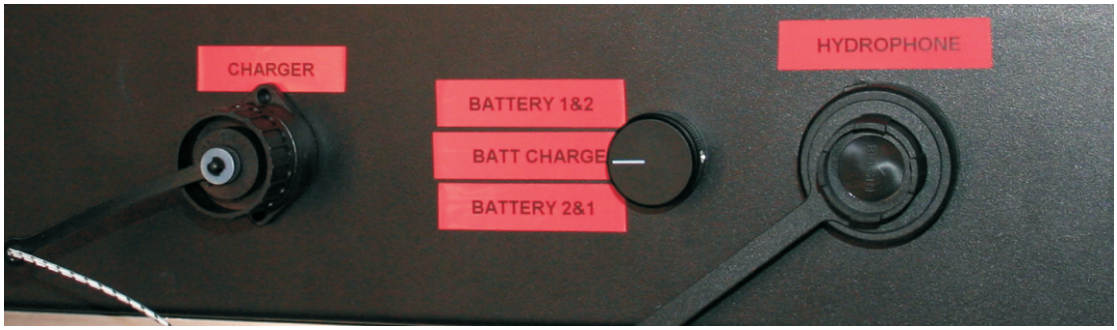
The third unit on this level is the digital audio interface on the right.

A separate manual is provided for this unit, and a computer setup process is needed to operate it.
In general the two knobs on the left regulate the input level.
The direct monitor knob regulates the output when the system is connected to an external amplifier, the STEREO indicator must be always ON, the Headphone plug and level knob is used to regulate the level at the headphones.

This unit is an E-MU 0202 USB audio interface. It can operate at 192kHz sampling rate, thus rapresenting signals up to about 90kHz in bandwidth. This is one of the rare units working at this sample rate and completely powered via USB. The drawback is that the inputs on this unit are less sensitive than those normally found on similar interfaces with real microphone level inputs. We will go back on this topic later in this manual.

The unit setup on the computer must be done following the provided instructions. A visit to the official E-MU website is strongly raccomended in order to obtain the latest drivers and software.

On the lower dock you find three objects.



At the left end there is the battery charger connector. It has a cap, that must be removed in order to connect the chargers.
The chargers' pug is polarized and can not be mis-inserted. The two chargers provide current to both batteries at the same time, provided the switch at the center is set at BATT CHARGE.

This switch has three positions:
BATTERY 1&2 uses battery 1 for the amplifier and battery 2 for the hydrophone;
BATTERY 2&1 uses battery 1 for the hydrophone and battery 2 for the amplifier;
BATT CHARGE is a safe position, with no powering to any device (it is the OFF position for the system) and enables the circuit for recharging.
To recharge the batteries the two recharges must be plugger to mains (220VAC). They automatic and disconnect the charging when it is complete. If the battery selector is operated while charging, the chargers are automatically disconnected.

It is better to switch the 1&2/2&1 selector every other hour in order to have a uniform battery consumption over the day.
Batteries are available for inspection opening the back cover of the case.
One fuse per battery is available over the positive wire.

A little phylosophy about this:
as the audio systems are really sensitive to AC noise, the analog part of this equipment runs on two batteries at 12VDC.
Batteries can not be charged while you are using the system, so as a default, your analog audio part will not be connected to 220VAC anytime.
The batteries as provided will give something like 40hrs of continous work. Please remeber to recharge the batteries anytime the system is not in use.
The only interconnection to 220VAC MAINS is via the computer that will be used to connect the audio interface. This interconnection with 220VAC may lead to unwanted noise, hard to determine and eliminate.
Using an inverter (12VDC to 220VAC) when on-board may also lead to unwanted noise in the system.

Geometry

We call HEAD the end of the hose that faces the ship, and TAIL the free end in the water.

The hydrophone is a two-element array, with a fixed 3 meters distance between hydrophone elements.
The hydrophones are firmly kept in position by means of two kevlar lines running along the hose.
The hydrophones are well visible in the hose, while other spacers help to keep the shape of the hose and compensate the fiber movements.

The head is made out of stainless steel AISI316, while the tail is made of a plastic resin (delrin).
The hose is a thin wall PU pipe.
The oil contained in the hose is an isoparaffine.

The cable is made of a polyurethan coated cable with 3 shielded twisted pairs and two power lines.
One twisted pair is unused.
An additional kevlar fibre (breaking strength approx. 400kg) keeps the cable as inextensible.

Please mind:

When you connect a computer to the USB port of the digital interface, noise could derive from the computer's power.
This kind of equipment is sensitive to interferences deriving from sources like VHF, radar, ground loops and engines.
Experience a little with grounding this equipment before using on operation.

Operations

The hydrophone must be deployed while the boat is slowly moving (usually max 3knots).
The rope tail must first go into the water, followed by the sensors and the cable needed.
The deployment must be done with the cable disconnected from the amplifier.
Once that the cable is in the water and that a cable lenght is set (the best option is with all the cable deployed), the cable must be tied as described later, and the connector can be plugged into the amplifier box.

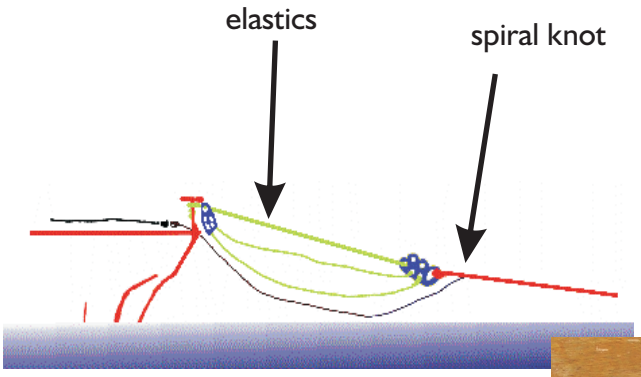
Towing

When towing please use some elastics [yellow in the drawing] in order to smooth the ship's movements propagating along the cable.
The elastics can be in different lengths in order to obtain a progressive retainment of towing. Firmly attach the elastics and a loose extra rope to the ship.

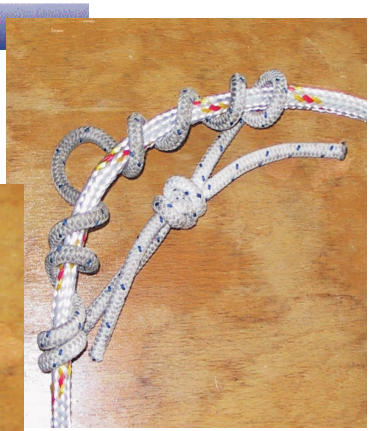
The electrical connector must be kept on-board well protected from water.
Do not fasten the black plugged cable to the boat; this is not a strenght element. The cable (black in the drawing) must be gently retained only.

For safety reasons, in case of emergency, you should always be prepared to release the towing. To be prepared to release the towing you should tight the towing to the boat via a safety release.

Should the connector go in the water it must be immediately washed shortly in freshwater and then carefully dryed at best. Periodical greasing of the connector will limit oxydation.



To obtain a grip at the desired lenght you will have to use a spiral knot as this in the pictures. This will help distributing the towing load over several centimetres of the cable.

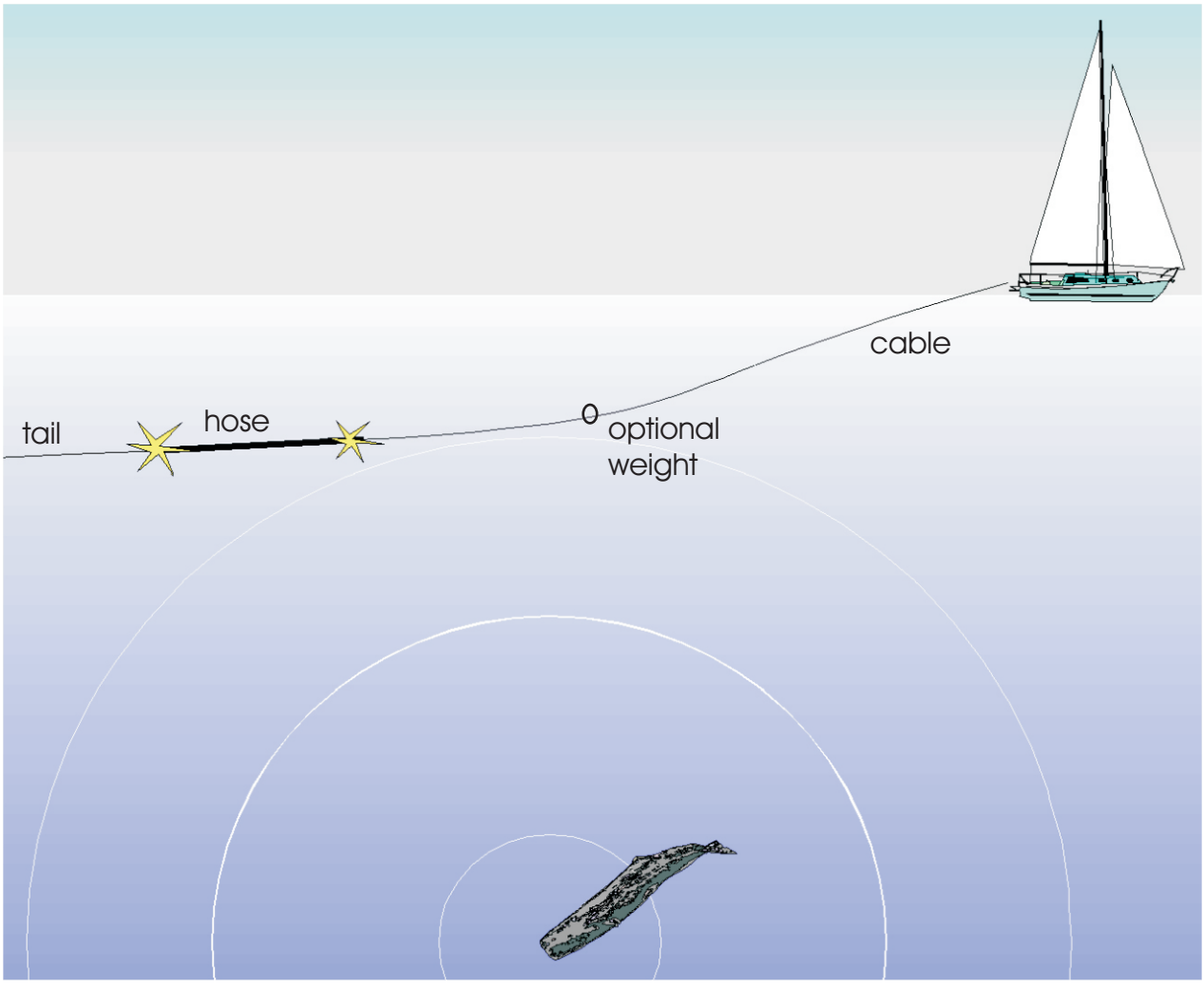


On operation

The two hydrophones contained in the hose will allow you to determine the direction from where an underwater sound is arriving, by ear, using the headphone, or usign a software like Ishmael (to obtain separately).

Sounds in the water will be heard arriving from different directions.
Listener`s perception of the sound source direction (according to the delay in the sound received at the two ears) will give the course to the source.
There will always be a left/right ambiguity, that will be solved manouvering the boat with a little experience.

It is not possible to determine now which will be the best operational depth in your conditions.
Due to physical reasons the best depth for acoustic propagation changes according to seasons.
For this system you will probably get the best results at depths of about 25/30 meters.
In general, depth increases releasing more cable in water and lowering the speed.



Technical specifications

Towed hydrophone
Two spherical ceramics in a PU moulding with sensitivity of -204dB re 1V/uPa and flat frequency response up to 130kHz
Two preamps (one for each sensor) are also moulded into resin and have a fixed gain of 29dB.
Total system sensitivity is -175dB re 1V/uPa.
Preamp output is rather flat from 10Hz to 250kHz.
Preamps have and additional internal high-pass filter set at 400Hz with a -3dB per octave attenuation.

Hydrophone connector is a standard splashproof (Ip68) connector with cap (FARNELL code 1308083l) with 7 pins.
Pinout is as follows:
PIN 1: red cable , +12VDC, powering
PIN 2: black cable, 0VDC, powering
PIN 3: white wire of the white/blue pair
PIN 4: blue wire of the white/blue pair
PIN 5: white wire of the white/green pair
PIN 6: green wire of the white/green pair
PIN 7: grounding and shielding (separate from 0VDC)

Preamp input impedance is 3,3 MOhm
Output impedance of the preamps is 10 Ohm
Output is balanced (differential).